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Revision 1

Project No. 23378

Field Sampling Plan for Lysimeter and Perched Water Monitoring of Operable Unit 7-13/14

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a. Washington Group International.

ABSTRACT

This plan outlines the sampling objectives, locations, priorities, and process for Operable Unit 7-13/14 vadose zone monitoring at the Radioactive Waste Management Complex (RWMC). The objectives of vadose zone monitoring are to determine if contaminants have migrated from the waste zone of the Subsurface Disposal Area at the RWMC to surrounding soils and perched water layers, collect data on the spatial extent of contamination, and satisfy monitoring requirements mandated by the Pad A record of decision. Data obtained from perched water and soil moisture monitoring are used to support the Waste Area Group 7 comprehensive remedial investigation/feasibility study.

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chain of custody
CRDL	contract-required detection limit
DOE	U. S. Department of Energy
DOT	U. S. Department of Transportation
EPA	U. S. Environmental Protection Agency
ER	Environmental Restoration
FFA/CO	Federal Facility Agreement/Consent Order
FSP	field sampling plan
FTL	field team leader
GFAA	graphite furnace atomic adsorption
INEEL	Idaho National Engineering and Environmental Laboratory
MCP	management control procedure
OU	operable unit
PPE	personal protective equipment
QAPjP	quality assurance project plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
RWMC	Radioactive Waste Management Complex
SAM	Sampling and Analysis Management
SAP	sampling and analysis plan
SDA	Subsurface Disposal Area
TPR	technical procedure

TSA	Transuranic Storage Area
USGS	United States Geological Survey
WAG	waste area group

Field Sampling Plan for Lysimeter and Perched Water Monitoring of Operable Unit 7-13/14

1. INTRODUCTION

1.1 Scope

This field sampling plan (FSP) supports the comprehensive Waste Area Group (WAG) 7 remedial investigation/feasibility study (RI/FS) under the Federal Facilities Agreement and Consent Order (FFA/CO) (DOE-ID 1991) at the Radioactive Waste Management Complex (RWMC). The role of lysimeter and perched water monitoring under the Operable Unit (OU) 7-13/14 investigation is to monitor and characterize contaminant migration in the soil moisture and perched water.

This plan has been prepared in accordance with guidance from the U. S. Environmental Protection Agency (EPA) on the preparation of sampling and analysis plans (SAPs). The SAP consists of two parts: this FSP and the *Quality Assurance Project Plan (QAPjP) for WAGs 1, 2, 3, 4, 5, 6, 7, 10, and Inactive Sites* (DOE-ID 2002a). The FSP describes the field activities that will occur as part of the investigation, and the QAPjP describes the processes and programs that ensure the data generated will be suitable for their intended use.

The Environmental Restoration (ER) Long-Term Operations Project will collect lysimeter and perched water samples routinely from RWMC area wells to monitor for evidence of contaminant migration from the RWMC Subsurface Disposal Area (SDA) and provide data that will aid in characterizing the spatial extent of contamination. The data collected will aid in the understanding of the fate and transport of contaminant migration from the SDA, help fill previously identified data gaps, and support the selection of appropriate remedial alternatives.

Sampling and analytical activities associated with lysimeters placed in the waste as part of the Probing Project are outside of the scope of this effort and are described in Salomon (2001).

1.2 Idaho National Engineering and Environmental Laboratory Background

The Idaho National Engineering and Environmental Laboratory (INEEL) is located 42 miles west of Idaho Falls, Idaho, and occupies 890 mi^2 of the northwestern portion of the Eastern Snake River Plain (Figure 1-1). The INEEL is bounded on the northwest by three mountain ranges: Lost River, Lemhi, and Beaverhead. The remainder of the INEEL is bounded by the Eastern Snake River Plain. Elevations on the INEEL range from 5,200 ft in the northeast to 4,750 ft in the southwest, with the average being 5,000 ft (Bowman et al. 1984). The INEEL was established in 1949 by the U.S. Atomic Energy Commission, predecessor to the U.S. Department of Energy (DOE), to build, operate, and test various nuclear reactors and fuel-processing plants and to provide support facilities. To date, 52 reactors have been constructed, some of which are still operable. Today, the INEEL also supports other government-sponsored projects, including energy, defense, environmental, and ecological research.

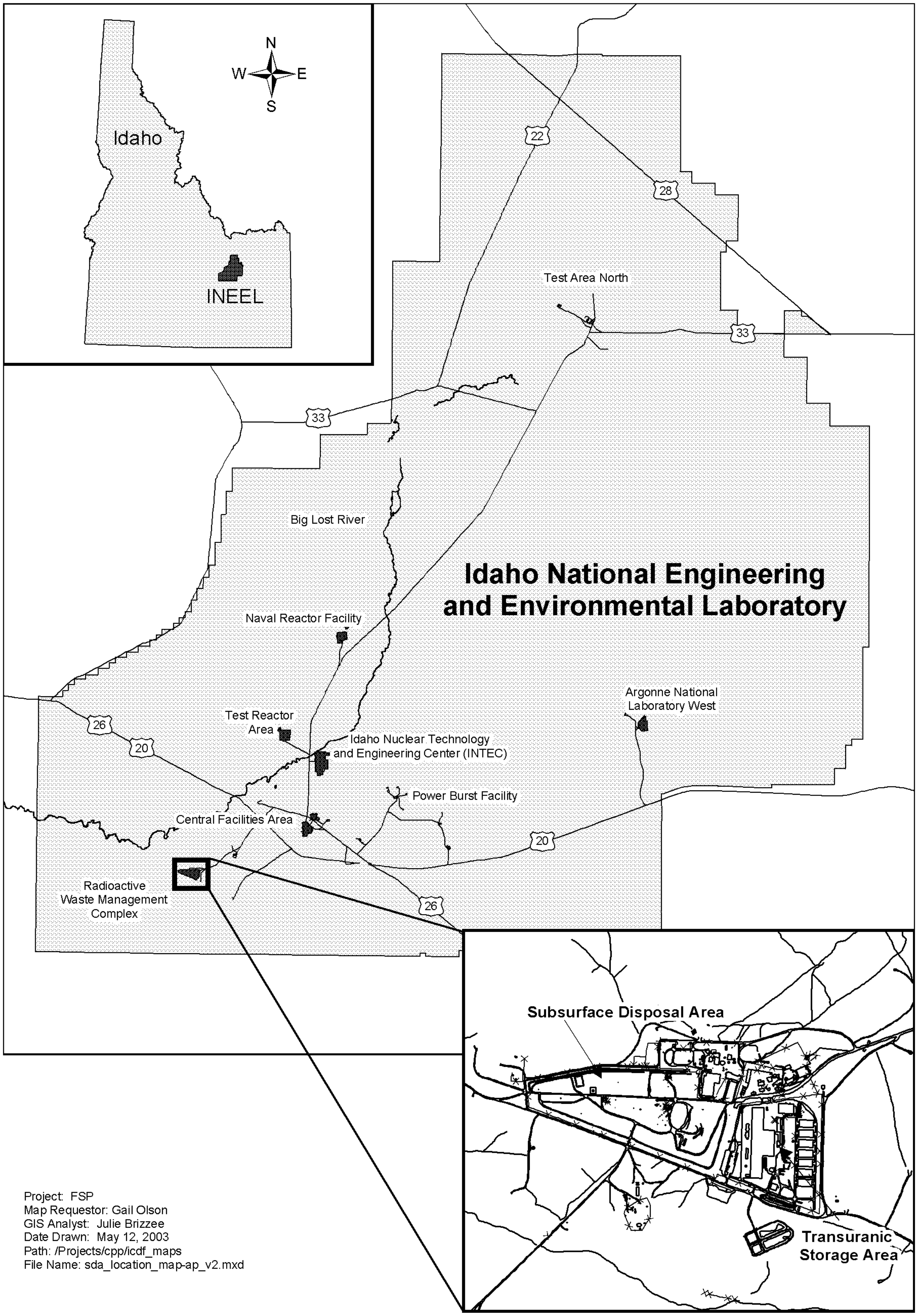

Figure 1-1. Location of the RWMC in relation the INEEL and Idaho.

The FFA/CO establishes the procedural framework and schedule for developing, prioritizing, implementing, and monitoring response actions at the INEEL in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the Resource Conservation and Recovery Act (RCRA); and the Idaho Hazardous Waste Management Act. The EPA proposed listing the INEEL on the National Priorities List of the National Contingency Plan on July 14, 1989 (54 Code of Federal Regulations [CFR] 29820). This was done using hazard ranking system procedures found in the National Contingency Plan. The hazard ranking system is a model that evaluates relative potential of uncontrolled hazardous substances to cause human health/safety or ecological/environmental damage. This system scores the relative potential on a scale of 0 to 100. Sites scoring 28.50 or higher are eligible for the National Priorities List. The score for the INEEL was 51.91. After considering public input during a 60-day comment period following the proposed INEEL listing, the EPA issued a final rule listing the INEEL site. The rule was published in the Federal Register on November 21, 1989.

Comprehensive INEEL historical and geological information relevant to the RWMC is provided in the *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area* (INEEL 2002).

1.3 Radioactive Waste Management Complex History

The Atomic Energy Commission selected the RWMC, located in the southwestern corner of the INEEL, as a waste disposal site for solid low-level radioactive waste in 1952 (Figure 1-1).

The RWMC encompasses a total of 177 acres and is divided into three separate areas by function: the SDA, the Transuranic Storage Area (TSA), and the administration and operations area. The original landfill, established in 1952, covered 13 acres and was used for shallow land disposal of solid radioactive waste. In 1958, the landfill was expanded to 88 acres. Relocating the security fence in 1988 to outside the dike surrounding the landfill established the current size of the SDA as 97 acres. The TSA was added to the RWMC in 1970. Located adjacent to the east side of the SDA, the TSA encompasses 58 acres. The TSA is used to store retrievable transuranic waste and ship it to the Waste Isolation Pilot Plant. The 22-acre administration and operations area at the RWMC includes administrative offices, maintenance buildings, equipment storage, and miscellaneous support facilities.

In the past, shallow landfill disposal of radioactive and hazardous waste was the technology of choice. Through 1970, the SDA was a disposal site for transuranic and mixed waste, most of which came from the Rocky Flats Plant in Colorado. Mixed waste that contained hazardous chemical and radioactive contaminants was accepted through 1984. Since 1985, waste disposal in the SDA has been limited to low-level radioactive waste from INEEL waste generators. Waste is buried in pits, trenches, and soil vaults.

1.4 Perched Water and Soil Moisture at the INEEL

INEEL contractors and the United States Geological Survey (USGS) have conducted numerous environmental studies and investigations in and around the RWMC to characterize soil moisture and perched water. The *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area* (INEEL 2002) contains a comprehensive presentation and discussion of these RWMC studies. A discussion of detected contaminants in soil moisture, perched water, and groundwater since 1997 is presented in the *FY 2002 Environmental Monitoring Report for the Radioactive Waste Management Complex* (INEEL 2003). A discussion on detected contaminants can also be found in the *Interim Risk Assessment and Contaminant Screening for the Waste Area Group 7 Remedial Investigation* (Becker et al. 1998).

Studies over the past 30 years or so have shown that perched water is transitory beneath the RWMC but has been detected in numerous boreholes at various times. Perched water bodies have been repeatedly identified at depths of approximately 80 to 110 ft and 200 to 220 ft, corresponding to the sedimentary B-C and C-D interbeds, respectively. Perched water typically occurs in fractured basalt above the interbeds, and samples are collected within or above the interbeds with either piezometers, bailers, or suction lysimeters. Often, perched water wells are dry or contain very little water.

Sources of perched water at the RWMC may be (a) surficial infiltration, (b) water moving laterally from the spreading areas of the Big Lost River, or (c) a combination of sources. Results from moisture monitoring (McElroy 1990) suggest that most of the net infiltration into surficial sediments is seasonal, occurring primarily in the spring when moisture is high and evapotranspiration rates are low. Snowmelt is the major contributor to recharge. A tracer test conducted by the USGS confirmed that at least some of the perched water in well USGS-092, around 214 ft deep, originated from the spreading areas (Nimmo et al. 2002). The four lined sewage evaporation ponds located approximately 400 ft south of the SDA should not be a source for perched water. Two of the evaporation ponds collect sanitary wastewater from the current RWMC operations and are lined with an impermeable plastic membrane. The remaining two ponds were built to support Pit 9 remediation and have compacted soil liners. These two ponds have not been used (INEEL 2001).

Historically, perched water has been observed in association with the B-C interbed in wells 78-1 and 10V (McElroy 1996). From 1992 to about May 1995, well 78-1 showed perched water thicknesses of up to 0.9 ft based on measurements made with a pressure transducer connected to a datalogger and measurements made with a steel tape. Well 78-1 was rebuilt in November 1995 because of concerns regarding open annular space and the possibility that water was entering the wellbore at an intermediate depth. Well 78-1 has been checked routinely for perched water since 1997, but none has been observed. Well 10V drilled in the western part of the SDA in 1994 had perched water with a measured thickness of 0.8 to 1.2 ft. This well has been monitored routinely for water since January 2002, and only trace water has been observed. This well was primarily completed as a vapor-monitoring well and only has a 1.5-in. piezometer to measure perched water.

The two wells associated with the C-D interbed that have consistently had perched water are well USGS-092, located near the center of the western half of the SDA, and well 8802D, located in the northeast part of the SDA (McElroy 1996). These wells are routinely monitored for contaminants to support the WAG 7 RI/FS.

2. SAMPLING OBJECTIVES AND ANALYTICAL PRIORITIES

The primary objectives in collecting lysimeter and perched water samples are to help determine whether contaminants are leaching from the waste in the SDA and provide data that will aid in characterizing the spatial extent of contamination. The data collected will aid in the understanding of fate and transport of contaminant migration from the RWMC SDA, help fill previously identified data gaps, and support the selection of appropriate remedial alternatives. Secondary objectives include better defining water movement through the vadose zone. The primary uses of the data gathered during lysimeter and perched water sampling are to identify contaminant trends and to provide information for calibration targets to support the source-term model for the baseline risk assessment.

Samples collected from the vadose zone are of limited volume due to arid conditions at the INEEL. Sample volumes collected can range from 100 to about 500 mL for some lysimeters and may be as little as a few drops in others. Because of the limited volumes, OU 7-13/14 has established analytical priorities for the lysimeter and perched water samples. The priorities are periodically reviewed and updated based on emerging issues and needs. In January 2003, the analytical priorities were modified to focus on contaminants of concern and maximize usability of the data for the remedia/investigation/basline risk assessment and feasibility study applications. The data quality object process (EPA 1994) was informally incorporated into the analyte selection process. The evaluation described below documents the process used for selecting and prioritizing analytes.

The following questions drove OU 7-13/14 analytical priorities:

- Which analytes are of interest?
- What is the need or justification for these analytes?
- What are the analytical priorities for limited volume samples?
- Should the analytical priorities be identical for each sampling round?
- Is it necessary to continue nitrate analyses annually at Pad A lysimeters (PA01, PA02, D06, and TW1)? And what about elsewhere?
- Is there a need to dedicate one round per year to the analysis of anions, cations, pH, and alkalinity and to rotate anions and cations into the priority list in an additional sampling round every year?
- Should cations, anions (including nitrates), pH, and alkalinity or contaminants of special interest be targeted in a fifth yearly sampling event?
- What should be done with excess sample volume (e.g., go to the top of the priorities list, analyze for an analyte not on the priorities list)?

The questions stated above were considered, and a proposal for analytical priorities was developed and presented to the Agencies for consideration. Tables 2-1 and 2-2 present the proposed analytical priorities for lysimeter sampling rounds. Table 2-1 shows the priorities for three of the four sampling rounds; Table 2-2 shows the priorities for the “nitrates round,” which is planned for sampling in the April through June timeframe. These priorities were developed based on the assumptions that:

Table 2-1. Routine analyses (three rounds per year).[a]

Analysis Priority	Preservative	CRDLS (pCi/L or mg/L)[b]	Sample Volume (mL)	Justification
C-14	None	<50	50	High-risk driver, highly mobile (K_d ~5 mL/g). Detected in vadose zone (perched water and soil moisture samples).
Gamma/Tc-99	HNO_3 to pH<2	<200 (gamma) <15(Tc-99)	50	A nondestructive analysis that provides data on several contaminants of concern; Tc-99 is a high-risk driver and highly mobile (K_d ~0 mL/g). Tc-99 is detected in the vadose zone (core, soil moisture, and perched water samples).
Uranium/plutonium/ americium	HNO_3 to pH<2	<2 for each	50	Contaminants of concern, risk drivers. Plutonium is a contaminant of special consideration.
Anions (October through December round only)	4°C	Varies (2 for NO_3)	25	Nitrate is a contaminant of concern; chloride is a component of magnesium chloride, which was applied to rods and serves as a water tracer.
Metals (October through December round only)	HNO_3 to pH<2	See Table 2-3	25	Note: Change from SW-846 to Contract Laboratory Program to reduce sample volume. Chromium is a potential model calibration target.
H-3	None	<250	50	Low-risk driver. Detected in vadose zone (perched water and soil moisture samples) at isolated locations.
Cl-36	HNO_3 to pH<2	100	500[c]	Not well characterized in the vadose zone; associated with beryllium blocks; detected in soil moisture in recent sampling.
I-129	None	<40	50	High-risk driver, highly mobile (K_d ~0.1). Intermittently detected in vadose zone (soil moisture) at levels >maximum contaminant level.
Np-237	HNO_3 to pH<2	<2	50	High-risk driver, highly mobile (K_d ~8). Not detected in vadose zone but detected in waste zone.

Yellow shaded items will be rotated to the end of the list in the January through March and July through September rounds.

a. Priorities for excess sample volume will be negotiated for each round based on emerging needs.

b. Detection limits (contract-required detection limits [CRDLs]) are as low as reasonably achievable, considering the extremely limited sample volume.

c. Lower detection limits have been achieved with less volume.

Table 2-2. Analytical priorities for the spring lysimeter sampling round.

Analysis Priority	Preservative	CRDL (pCi/L or mg/L)[a]	Sample Volume (mL)	Justification
Anions (required only at Pad A)[b]	4°C	Varies (2 for NO_3^-)	50	Nitrates required on Pad A samples. Anions needed for soil chemistry.
pH, alkalinity (field measurement)	Titrated	NA	25	Needed for defining the chemical environment of the soil moisture and determining the potential for contaminant transport. HCO_3^- can be calculated from alkalinity data.
Metals	HNO_3 to pH<2	See Table 2-3	50	Cations needed for characterizing the soil moisture chemistry and charge balance; chromium data needed to evaluate chromium trends in some wells in the aquifer.
Cl-36	HNO_3 to pH<2	~3[c]	500 mL (combine samples into one set of sample bottles)	Not well characterized in the vadose zone; associated with beryllium blocks; detected in soil moisture in recent sampling.
Tc-99	HNO_3 to pH<2	<15		Contaminants of concern, risk drivers.
Uranium	HNO_3 to pH<2	<2		
C-14	None	<50	50	High-risk driver, highly mobile (K_d ~5 mL/g). Detected in the vadose zone (perched water and soil moisture samples).

An annual meeting will be held to decide priorities beyond anions for yellow shaded items. Note that additional volume will not improve the detection limits for non-radionuclides.

a. Detection limits (CRDLs) are as low as reasonably achievable, considering the extremely limited sample volume.

b. Nitrate analysis (obtained by anions) is required only for the Pad A lysimeters (PA01, PA02, D06, and TW1).

c. Lower detection limits have been achieved with less volume.

- There will be four sampling rounds per year.

- Nitrate analyses are still required once per year in the Pad A lysimeters (PA01, PA02, D06, and TW1) per the Pad A record of decision (DOE-ID 1994).

- Primary driving considerations for establishing priorities are: SDA source term, contaminant mobility, previous detections, and risk (as defined by modeling in the OU 7-13/14 ancillary basis for risk analysis [INEEL 2002]) and the performance assessment (Case et al. 2000) and composite analysis (McCarthy et al. 2000) modeling.

The priorities shown in Table 2-1 focus on radionuclide contaminants (nonshaded items) for two rounds; the third round (October through December) would rotate calibration targets (chromium and chloride) and nitrates into the priority list (the shaded rows). Ni-59 and Ni-63 were originally on the priority list. However, 500 mL of sample volume is required for each analysis, which essentially precludes obtaining an analysis. Therefore, nickel isotopes were removed from the priority list.

Priorities for the remaining round (April through June), known as the "nitrate round," are specified in Table 2-2. The Table 2-2 priorities were established to:

- Meet the presumed requirement to obtain nitrates data annually (nitrates are the #1 priority)
- Contribute to the understanding of geochemistry in the soil moisture to assess migration potential
- Assess migration of magnesium chloride in the vadose zone
- Assess the nature and extent of contamination associated with OU 7-13/14
- Provide data on potential calibration targets (chromium and chloride).

Table 2-3 lists detection limits for cations (metals) using the limited sample volume expected. Table 2-1 and 2-2 priorities are applicable to FY-03 only and will be re-evaluated for subsequent sampling rounds, recognizing that data consistency is a priority. Table 2-2 priorities ensure that a snapshot of the geochemical conditions for the entire SDA is obtained, while meeting the nitrates data need. The approach also provides data on chromium and chloride concentrations, which could be used to evaluate the flow and transport model. Obtaining followup analyses in the October through December sampling rounds (Table 2-1, anions and metals) is desirable, but obtaining anions and cations twice per year every year may not be necessary once this year's data are evaluated. The combined Table 2-1 and 2-2 priorities ensure that:

- Analysis for high-priority radionuclides occurs three times per year
- Nitrates are the #1 priority once per year
- Data for potential model calibration attempts are obtained twice in FY-03.

Occasionally, a lysimeter will yield as much as 600 mL of sample volume. Use of excess sample volume will be determined routinely based on emerging needs.

Table 2-3. Detection limits for cations (25-mL sample) using Contract Laboratory Program.

Analyte	CRDL[a] (ug/L)	Method	Analyte	CRDL (ug/L)	Method
Aluminum	200	ICP[b]	Zinc	20	ICP
Antimony	60	ICP	Lead	3	GFAA
Arsenic	10	GFAA[c]	Magnesium	5000	ICP
Barium	200	ICP	Manganese	15	ICP
Beryllium	5	ICP	Nickel	40	ICP
Cadmium	5	ICP	Potassium	5000	ICP
Calcium	5000	ICP	Selenium	5	GFAA
Chromium	10[d]	ICP	Silver	10	ICP
Cobalt	50	ICP	Sodium	5000	ICP
Copper	25	ICP	Thallium	10	GFAA
Iron	100	ICP	Vanadium	50	ICP

a. CRDL = contract-required detection limit based on a minimum sample volume of 25 mL.
b. ICP = inductively coupled plasma.
c. GFAA = graphite furnace atomic adsorption.
d. Detection limit for chromium may be as low as 2 ug/L.